equivalent slab phantom (PTW RW3). The Starcheck data acquisitions were done with the Multicheck software with only 100-200 MU and data analysis was handled by the MEPHYSTO software. Reference profiles measured in water were compared with profiles obtained with 2D array and Gafchromic films using the 2%/2mm gamma-index criterion. Output factor measurements were carried out for the central chamber of the array using its absolute dose value, and the results compared with the reference values.

Results: Comparison between dose profiles obtained with Starcheck 2-Array, chamber, diode and Gafchromic film showed a good agreement and they satisfied gamma analysis (2%/2mm) for almost all the nominal energies and collimators. The high spatial resolution of Starcheck allows accurate evaluation of penumbra, symmetry, flatness and field size and the results showed dosimetric differences less than 1%, 1mm for all the energies in the reference collimator (10 cm). The absolute dose difference at the Zref (IAEA398) between central chamber of 2D-array and Advanced Markus was in the order of 1% for 6 and 9 MeV and was almost 1.5% for 9 MeV. Furthermore, the difference between output factor obtained with the 2D-array and other dosimeters was in the order of 2% for all collimators in different energies except for the smallest collimator (4cm) where the output factor deviated more than 3% from the other results. However, the results for beveled collimators were not acceptable due to angular response variation of chambers.

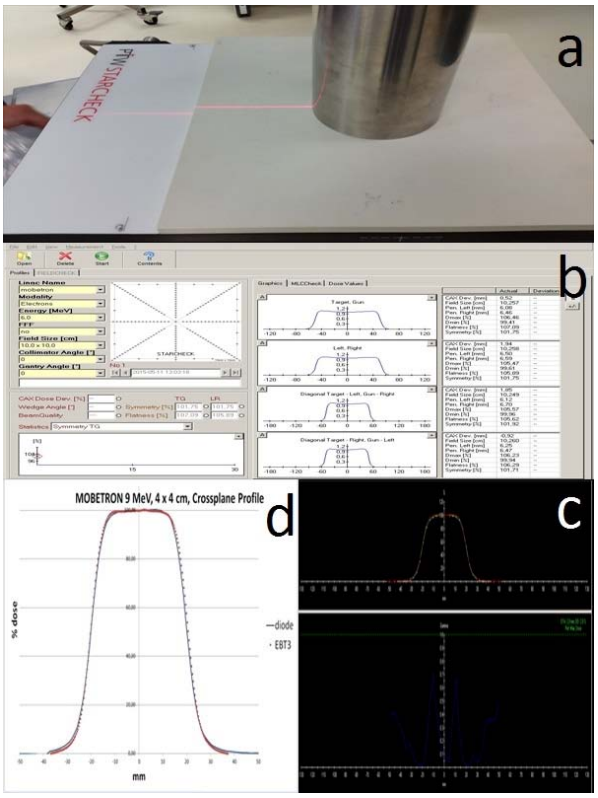

Fig.1. Starcheck 2D array (a), data analyze with Multicheck software (b), crossplane profiles comparison: Starcheck and diode (c), Starcheck and EBT3 (d)

Conclusion: The high spatial resolution, very small detector size and specific arrangement of this 2D array can be really suitable for dosimetry in IOERT. Additionally, it can reduce setup time and dose consumption more than 30% for frequently QC procedure.

EP-1582

Retrospective study of IORT sarcoma treatment using an innovative dedicated TPS

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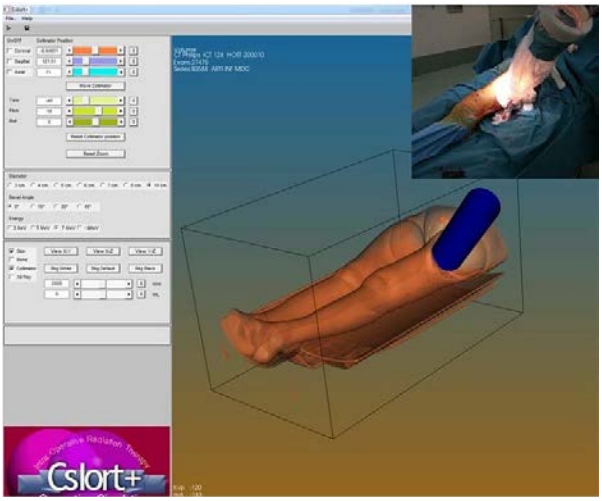
Purpose or Objective: The IORT dedicated Treatment planning system (CSRAD+), already validated on simple geometries, has been used to perform calculation on patient-like geometries and to compare the measured and the calculated dose distribution in a clinical configuration. In this study, sarcoma cancer patients have been considered. In sarcoma IORT treatments, the air gap between target and applicator and the extended dimensions are critical parameters that must be fully taken into account. The TPS and MC calculations are mandatory for documenting the dose delivery in order to potentially improve the treatment technique and to better evaluate dose effect correlation.

Material and Methods: Twenty six patients with sarcoma cancer have been treated using NOVAC 7 with an energy from 7 to 9 MeV, an applicator diameter from 40 to 100 mm, delivering a dose from 10 to 16 Gy. In vivo dosimetric data collected during IORT using Gaf films, have been used as the gold standard for testing the accuracy of the algorithms implemented in the TPS. CT images of five representative patients have been used to reproduce the surgery room scenario, using the collected data and taking into account tissue removal during the surgery procedure. Then, the CT images were imported in the TPS and used in order to perform an accurate dose calculation. The dose distribution have been compared with the in vivo dosimetry in order to perform a sensitivity analysis.

Results: The TPS algorithms including the inhomogeneity correction have been investigated considering the clinical scenarios. The algorithm including the inhomogeneity correction allows the best agreement between the in-vivo dosimetry results and calculated dose, for mobile IORT accelerator. CSRAD+ permits to make a virtual docking, to delineate the target ROI, and to evaluate the dose distribution and the dose volume histogram. The sensitivity analysis revealed potential setup uncertainties (up to 80%) due to the manually performed alignment procedure in the surgical room and inaccuracy on target thickness when blood and air are present during the docking.



Conclusion: The developed CSRAD+ shows a good agreement with experimental data and could replace the time consuming MC absolute dose calculation, becoming a potential on-line aid for physician and physicist in the surgical room. The CSRAD+ could represent a training tool for

IORT staff and could provide a provisional plan that includes also DVH and MU calculation.

EP-1583

An automated Monte Carlo plan verification system for spot-scanning proton therapy

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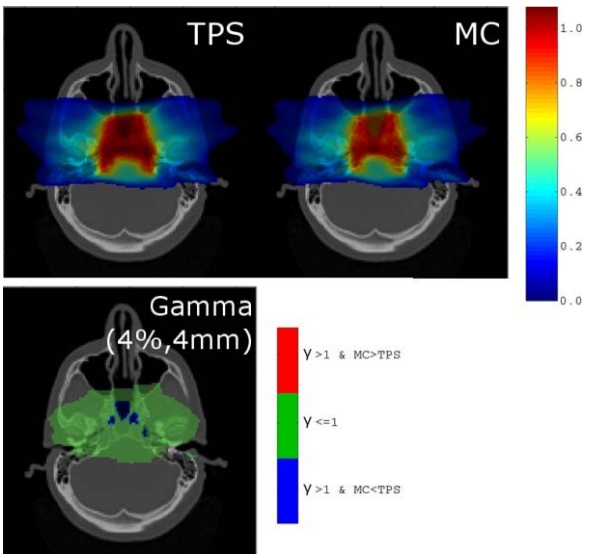
Purpose or Objective: Monte Carlo (MC) recalculation of spot-scanning proton therapy treatment plans can provide an independent verification of monitor units required for delivery, and reduce the time treatment rooms need to be reserved for patient specific QA. We describe the development of such a MC verification system for a clinical facility.

Material and Methods: Realistic clinical beam models were developed by matching simulations (using GATE/GEANT4) to measurements made in a clinical beamline. They consist of a tuned physics list, a lookup table relating each of the 115 nominal beam energies to a tuned spot energy (mean and standard deviation) and phase space parameters which allow spot sizes to be properly modeled for any combination of energy and nozzle extension. For all beam energies simulations accurately reproduce both integral depth dose profiles (>97% of data-points pass a local gamma analysis at 2%/2mm) and lateral profiles measured in air and in solid water (with a 0.2 mm maximum difference). The model was further validated against a series of simple test plans which were optimized in the clinical Treatment Planning System (TPS) to produce uniform dose volumes at various depths in water.The automated MC system can process, simulate and analyse treatment plans without user input once it receives the TPS files.

Results:



The system was tested for a three field (11k spot) base of skull treatment plan computed in a patient CT dataset. Simulations were split into 40 calculations over a 10 quad-core CPU cluster, requiring <30 minutes to achieve dosimetric uncertainties (within the 90% isodose volume) of <1%. The figure demonstrates the broad agreement between the TPS (left) and the MC simulation (right). The *local* gamma pass rate between the two (bottom) is 97% at 4%/4mm (green voxels pass, red / blue voxels fail). This should be interpreted in the context of this being a highly inhomogeneous target site: Differences occurred only in heterogeneous regions where the TPS's analytical dose calculation would be expected to model dose deposition less accurately than MC systems. For example, the MC simulations predict a lower dose around the sinus air cavities than the TPS.

Conclusion: We have demonstrated that the MC verification system can accurately reproduce the dose distribution predicted by a clinical TPS. Further validation work is ongoing using a variety of plans and phantom measurements. Once clinically commissioned, the system can be used as an independent dose checker, reducing on-set verification time.

EP-1584

Experimental validation of Tomotherapy to VMAT plan conversion using RayStation Fallback Planning

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Purpose or Objective: To establish the workflow & methodology and to perform an experimental validation of treatment plan conversion from Tomotherapy HD machine (Accuray) using dynamic jaws to a True Beam (Varian) Linac. For this purpose, the RayStation (RS) TPS using fallback planning (RFP) is currently tested. An end-to-end set of phantom configurations of increasing complexity are presented. The ultimate goal is to validate this process in order to minimize the impact of machine downtime on patient treatments.

Material and Methods: Four phantom based treatment plans were generated in the Tomotherapy Planning Station. These plans were mimicked with RFP for the TrueBeam using X6-FFF dual-arc VMAT. The first three cases planned on the Cheese Phantom (Std. Imaging) consisted of 1 to 4 target dose levels and 3 OARs, using heterogeneous inserts for the last one. The 4th case was an integrated boost H&N treatment with 3 target dose levels planned on an anthropomorphic phantom (H&N, IBA). Original Helical Tomotherapy (HT) and RS fallback plans were delivered respectively on each machine. Ion chamber (A1SL, Std. Imaging) and Gafchromic EBT3 (ISP) films were used to measure absolute and planar doses. First, for both machines beam delivery vs. treatment plan was evaluated as a baseline for absolute dose, gamma (γ) passing rate (criteria 3%/3mm) and overall uncertainties. Secondly, in order to ensure that the difference between the two calculated dose distributions (TPS_TOMO / TPS_RAYSTATION) matched the differences between the two measured film dose distributions (Film_TOMO / Film_RAYSTATION), a γ difference (5%/5mm) was performed.

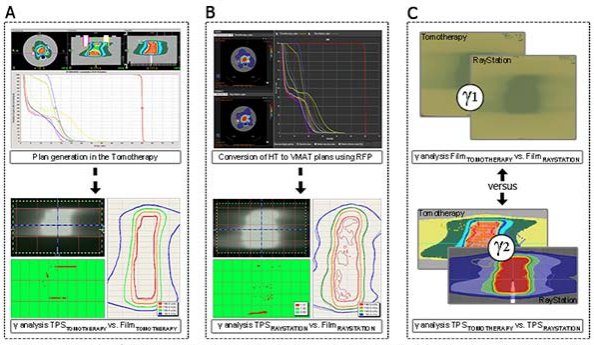

Figure 1 - Principle of the method implemented to validate plan conversion. (A) Helical Tomotherapy TPS dose distributions calculated on the Cheese Phantom is delivered on the Tomotherapy and measured with ion chamber and film. Gamma evaluation (3%/3mm) is performed using FilmQA Pro. (B) same as (A) but mimicked with the RayStation TPS Fallback Planning and delivered on the TrueBeam. (C) Gamma-index evaluation (5%/5mm) for both film measurements (γ1). Gamma-index (5%/5mm) for both TPS dose distributions (γ2). The average γ difference (γ1 - γ2) is performed between them.

Results: First, gamma evaluation was (99.1±0.6)% for HT and (99.5±0.4)% for RS fallback plans while absolute dose differences between calculations and ion chamber measurements were respectively 0.9% for HT and -0.7% for RS on average for all end-to-end tests. Secondly, average γ difference between calculated doses TPS_TOMO /